Heat Stress Program

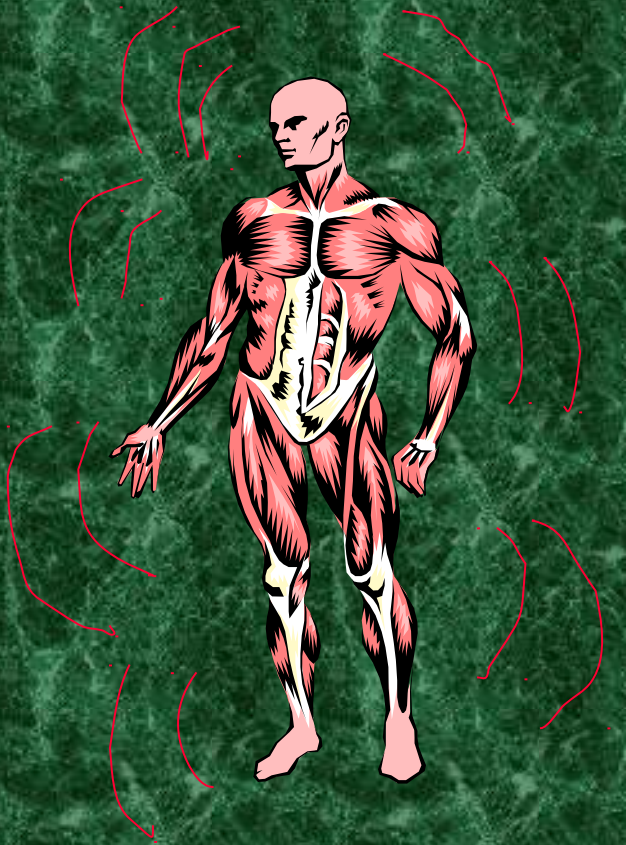
Navy Environmental & Preventive Medicine Unit No. 2

Norfolk, VA

What part of the brain acts as the body's thermostat

Effects of Heat Stress on the Body

- The body tries to regulate internal temperatures naturally by generating heat
- The body is sensitive to external factors →Climatic & Non-Climatic
- Failure of natural cooling ability causes heat stress



Heat Stress

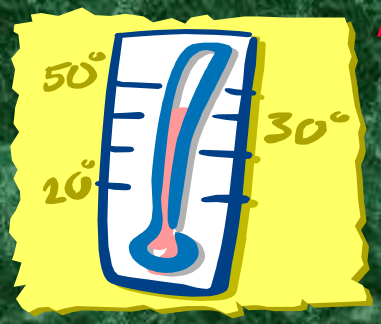
- *DEFINITION*: Relative amount of thermal strain from the environment

- Results from a combination of factors either *climatic* or *non-climatic*. These factors may stress the body as it attempts to regulate its internal temperature

CLIMATIC FACTORS

1. Thermal radiation

2. Air temperature



3. Air flow

4. Humidity

NON-CLIMATIC FACTORS

- **Wearing protective clothing**
  - Chemical Suits
  - Fire Fighting G
  - Welding Gear

NON-CLIMATIC FACTORS

- Heavy Workload/Exercise – Usually in combination with high humidity &/or hot environment (Climatic)
- Illness
- Intoxication
- Poor physical condition

Heat Acclimatization

- After most individuals experience repeated exposure → *physiologic adaptations occur*
- Body becomes more efficient at coping with heat stress

Approximately how many days away from the heat-stress environment does it take the body to lose its acclimatized state

Equation for Thermal Balance

- Climatic and physiological factors combine to determine whether the body gains or loses heat to the surrounding environment

Heat Stress → M ± C ± R = E

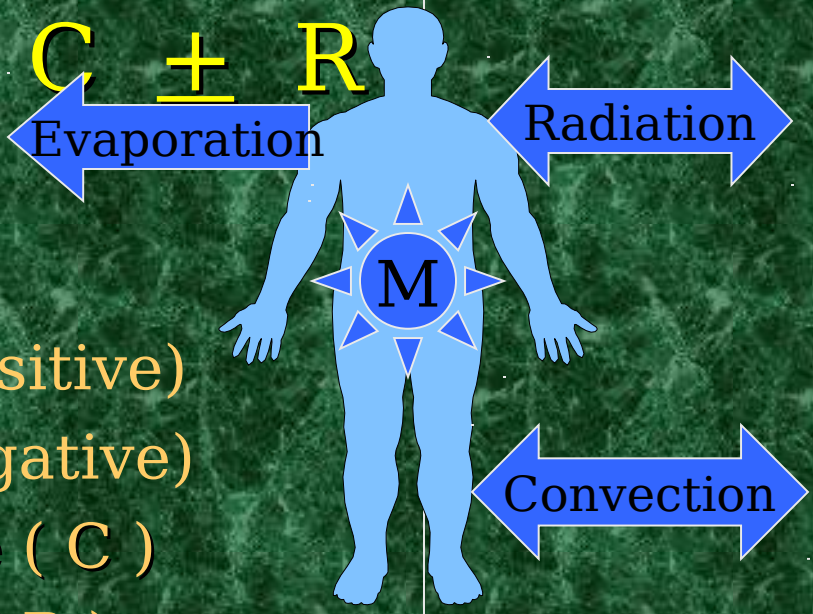
Remember

Metabolism (M) always + (positive)

Evaporation (E) always - (negative)

Convective heat exchange rate (C)

Radiation heat exchange rate (R)



Terms

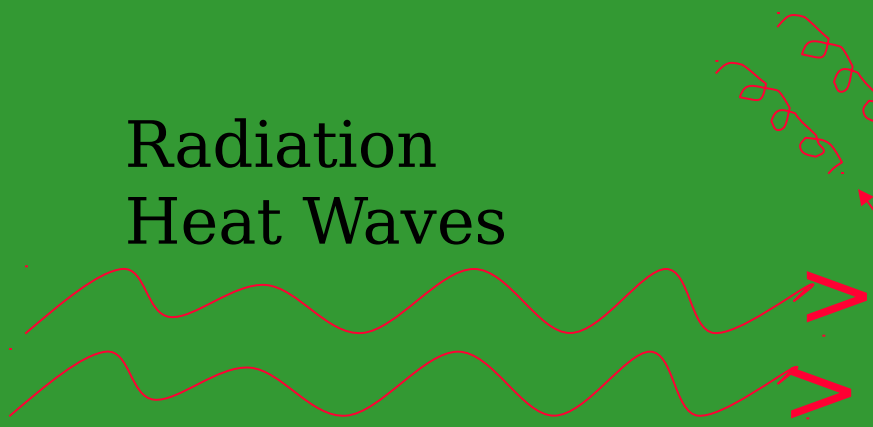
- ***Metabolism***: Flow of energy and the associated physical & chemical changes constantly taking place in the billions of cells that make up the body
- ***Convection***: Exchange of heat between the skin and the surrounding air
- ***Evaporation***: This process cools the skin which in turns, cools the whole body.
- ***Radiation*** (thermal): Absorbed radiant energy becomes thermal energy and results in an increase in the temperature of the absorbing body.

Mechanisms of Heat Loss

Walls

Evaporation

Radiation
Heat Waves

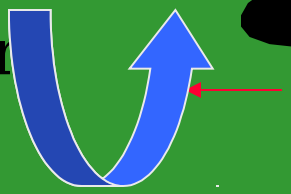


Safety

Conduction to air

Conducti
on
to
Objects

Air Currents
(Convection



3 Different Methods of Heat Transfer:

- CONVECTION:
  - **Heat transfer from skin to air and air to skin**
- CONDUCTION:
  - **Heat transfer from one item to another through direct contact**
- RADIATION:
  - **Transfer of thermal energy by wave motion from one object to another without warming of the intervening space**

Body Cooling Process

- Body cools itself with a combination of radiation, convection, and evaporation
- The hypothalmus acts as the body's thermostat
- If the body is no longer able to adjust heat effectively → *hypothalmus stops working*
  - Then it becomes prone to heat injuries

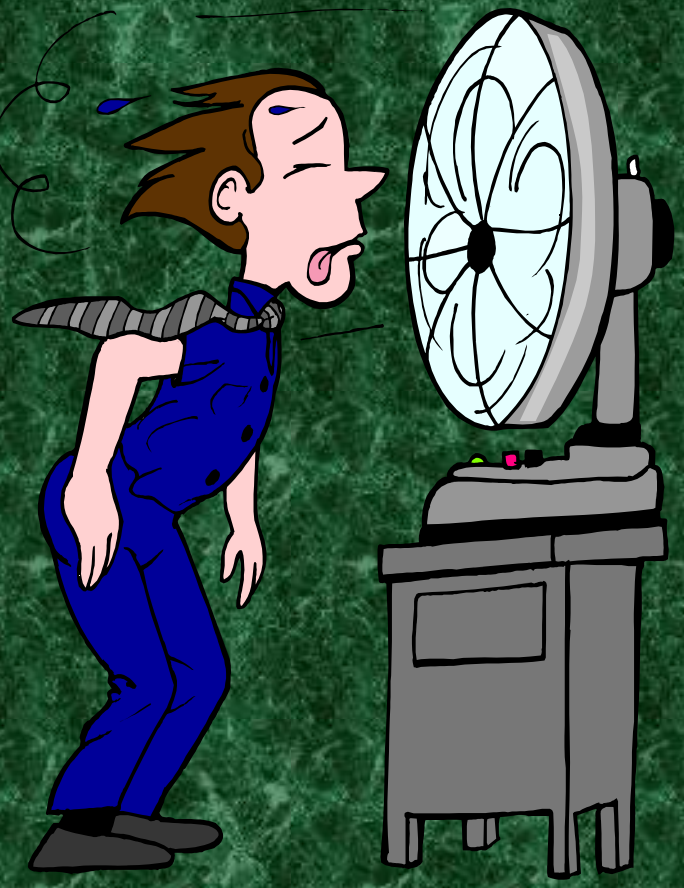
General Symptoms of Heat Stress

- Fatigue
- Severe headaches
- Nausea
- Decreased performance
  - Physical
  - Mental

Heat Injuries

Four major types of injuries:

1. Heat Rash
2. Heat Cramps
3. Heat Exhaustion
4. Heat Stroke



Heat Rash

- Symptoms
  - Red raised rash, impairs sweating and decreases effectiveness of sweating
- Treatment
  - Keep area clean and dry
  - Avoid tight clothing

Heat Cramps

- Symptoms
  - Cramps in large muscles(stomach or legs) caused by electrolyte imbalance
  - Moist, cool skin
- Treatment
  - Massage effected area
  - Analgesics for pain
  - Salt food to taste

Heat Exhaustion

- Peripheral vascular collapse from excessive salt loss and dehydration
- Symptoms
  - Pale, moist skin
  - Rapid, thready pulse
  - Elevated blood pressure
  - Tingling/trembling and weakness in arms/legs
  - Dizziness, nausea and vomiting

Heat Stroke

- Thermoregulatory mechanism failure with the main avenue of heat loss (sweating) being blocked (***hypothalmus fails***)
- Symptoms
  - Skin--Hot, Flushed, Dry
  - Pulse fast and strong
  - Breathing deep
  - Vomiting, Cramps, Twitching
  - Will go into shock
- Can Be FATAL!

Heat Stroke

- First Aid
  - CALL A MEDICAL EMERGENCY!
  - Move victim to cool space
  - Remove clothing
  - Cover with cold, wet material
  - Gently massage arms and legs
  - Lower body temperature to 1

Navy Heat Stress Control Program

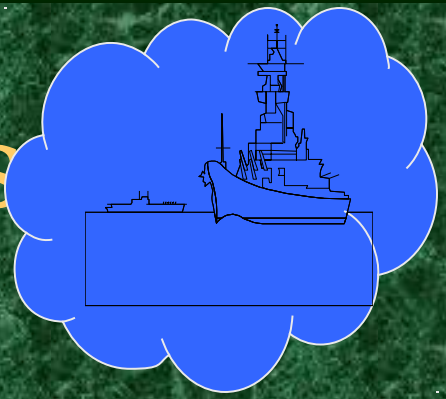
REFERENCES

- OPNAVINST 5100.19C CH-2
  Chapter B2

http://www.norva.navy.mil
http://neds.nebt.daps.mil/Directives/dirinde

- NAVMED P5010
- NEHC TM92-6

Responsibilities



- CNO
  - Set Policy in OPNAVINST 5100.19 (series)
- NAVSEA & TYCOM's
  - Design better ventilation
  - Provide funds for engineering controls
  - Assist in repairs
- INSURV
  - Inspects the Heat Stress Program for compliance

Responsibilities

- Commanding Officer
  - Establishes and enforces Heat Stress Program
  - Ensures Heat Stress deficiencies corrected
  - Requests assistance to identify problems
  - Reports injuries & conducts investigations
- Engineering Officer, Supply Officer, and MDR
  - Have specific duties according to OPNAVINST 5100.19 (series)

Heat Stress Program Elements

PROGRAM ELEMENTS

- **IDENTIFY AREAS**
  - Determine potential heat stress areas
  - Include weather and flight deck areas
  - Post Thermometers
    - **Hang with non-conductive materials**
  - Log Temperatures
  - Take hourly readings as necessary
  - Notify Monitors

PROGRAM ELEMENTS

- **HEAT STRESS SURVEY**
  - * WBGT METER
    - Conduct WBGT heat stress meter surveys
    - Contact Engineering Dept. or MDR for readings
    - Ensure all ships have 2 (Engineering & Medical)
  - * TRAINING
    - Only qualified monitors take readings
    - Use with Physiological Heat Exposure Limit (PHEL) chart for stay-times
    - Consult OPNAVINST 5100.19 (series) for guidance

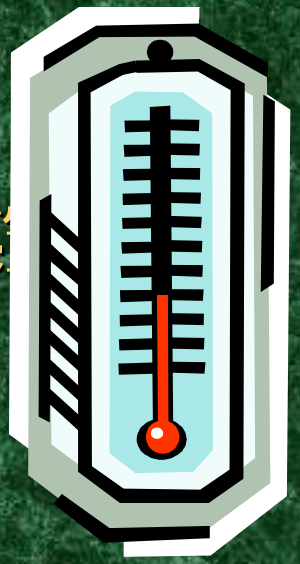
PROGRAM ELEMENTS

- **SAFE WORK SCHEDULES**
  - * **PHEL CHART**
  - * **RECOVERY**
- **IDENTIFY AND CORRECT CAUSES**
  - – Engineering controls
  - – Use available SHIPALT funding
- **INVESTIGATE & REPORT**

DRY-BULB THERMOMETERS

DRY-BULB THERMOMETERS

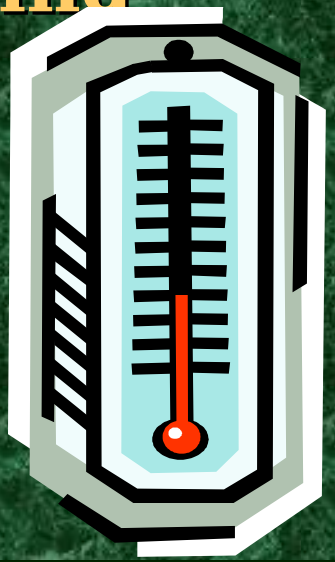
- Mount alcohol in glass (NSN 9G-6685-00-243-9964) thermometers:
  - In watch & workstations throughout ship where heat-stress conditions exist
  - In non-air conditioned spaces, not normally manned, but personnel may work in (e.g. storerooms)
- Hang where temp are represented best
  - If DB thermometer is 5 ° F or greater, then the DB therm is not representative of the space temp and must be be relocated, replaced, or validated by aligning the etch mark with the freezing point (32° F)



DRY-BULB THERMOMETERS

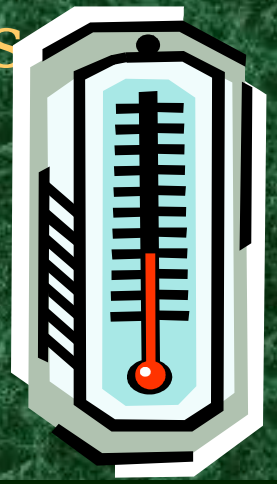
- Replace or validate DB thermometer if 5° F difference b/t hanging DB and the DB temp measured with the WBGT meter
- Do NOT need to be calibrated
- Do NOT need No-Cal stickers

- Placed in / out of air stream
- At least 2 FT from supply vent opening



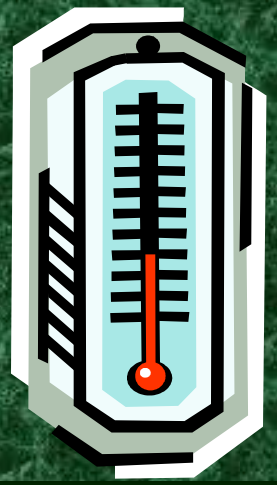
DRY-BULB THERMOMETERS

- Mount
  - If repairs or maintenance are being performed in heat-stress areas
  - Main machinery spaces (firerooms & enginerooms)
  - Auxiliary machinery spaces
  - Emergency diesel spaces (Other engineering spaces containing heat sources)
  - Dry cleaning plants
  - Bake shops
  - Steam catapult spaces.
  - Launderies
  - Sculleries
  - Galleys



DRY-BULB THERMOMETERS

- Every 4 hours for manned spaces if DB temp do not exceed 85° F
- Every hour for manned spaces if DB temp exceed 85° F
- Every hour at temporary installations for repairs or maintenance conditions



WBGT METER

WBGT:

- **Wet Bulb Globe Temperature**
  - Model RSS 220, NSN 7G-6685-01-055-5298
  - Not accurate below 65° F
  - Position meter where personnel normally works
  - Let WBGT meter equilibrate with environment for 5 minutes → then surveyor shall wait for 3 min for each subsequent watch/work station in the space
  - Do not shield WBGT meter from airflow or heat sources
- **WBGT = 0.7WB + 0.2GT + 0.1DB**

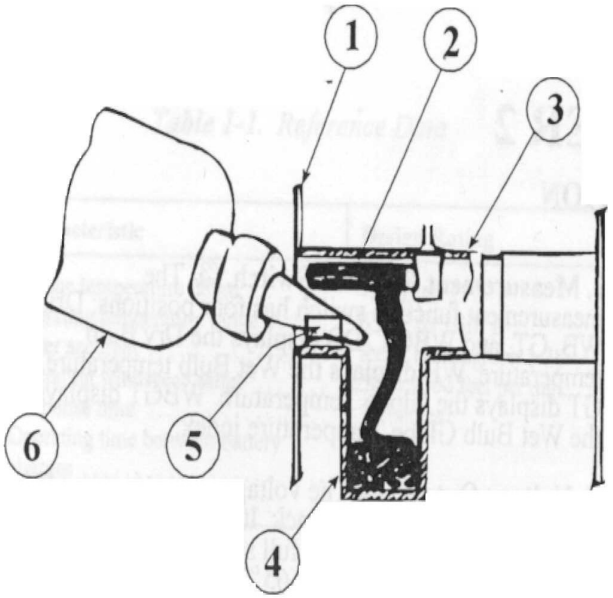
WBGT METER

- Model RSS 220
  - Low-Tech
  - Durable
  - Generally Reliabl
- Model 960
  - High-Tech
  - Expensive
  - Parts Limited
  - Poor Durability

WBGT Meter Operation

- **Install globe sensor (do not touch globe)**
- **Fill wet bulb reservoir from water bottle**
- **Reservoir is accessible through tunnel marked Water Fill**
  - **When full, water should completely cover sponge**
  - **Pour excess water out**
  - **If dry bulb sensor gets wet, dry it off**

NAVSEA SNOOO-AA-MMO-010
Meter RSS-220



1. Side of case.
2. Wet bulb sensor, covered by wick.
3. Tunnel assembly.
4. Water receptacle.
5. Dry bulb sensor.
6. Water bottle.

Figure 2-2. Filling the Wet Bulb Reservoir

WBGT Meter Operation

- Turn power switch to check
- Wait 5 minutes
- Turn dial to each function (WB, dB, GT, WBGT)
  - Each position must read 100.00 +/- .2
- Hand hold in each environment to be measured
  - Use neck strap to keep 18” from body

WBGT Meter Operation

- Wait 5 minutes with power switch to "***ON***" in each location to be measured.
- Take measurement at each function (WB, dB, GT, WBGT)
- Each meter reading should be taken at location of hanging dry bulb thermometer
- Keep WATER FILL side of meter toward ventilation flow

Manual Calculation

- (0.1 x dB) + (0.7 x WB) + (0.2 x GT) = WBGT
- Manual calculations must be performed on highest WBGT reading

WBGT Meter Value Relationship

- WB < dB < GT
- WB < dB < WBGT < GT
- WB < WBGT < dB < GT (Normal)

Common Problems

- ☹Operator may have rushed, not allowing meter to stabilize
- ☹Misread, misrecorded information
- ☹Meter malfunction
- ☹Ventilation not flowing into proper end of meter
- ☹Operators body shielded meter from source of radiated heat

Common Problems

- ☹Meter held too close to body
- ☹Meter not held close enough to dry bulb thermometer
- ☹Dry bulb thermometer not in calibration

TRAINING FOR HEAT STRESS MONITORS

Heat Stress Monitors

- Minimum knowledge required for heat stress monitors:
  - ✓ Know all references
  - ✓ Know the WBGT Technical Manual
  - ✓ PQS qualified (proficient)
  - ✓ Assemble and use the WBGT meter
  - ✓ Manual calculations
  - ✓ Choosing and interpreting PHEL

Heat Stress Monitors

- ✓ Use of motorized psychrometer
- ✓ Complete forms
- ✓ Attend a Heat Stress training course either at FTC or NEPMU
- ✓ Eight o’clock Reports to the CO - are the responsibility of the Medical Department Representative

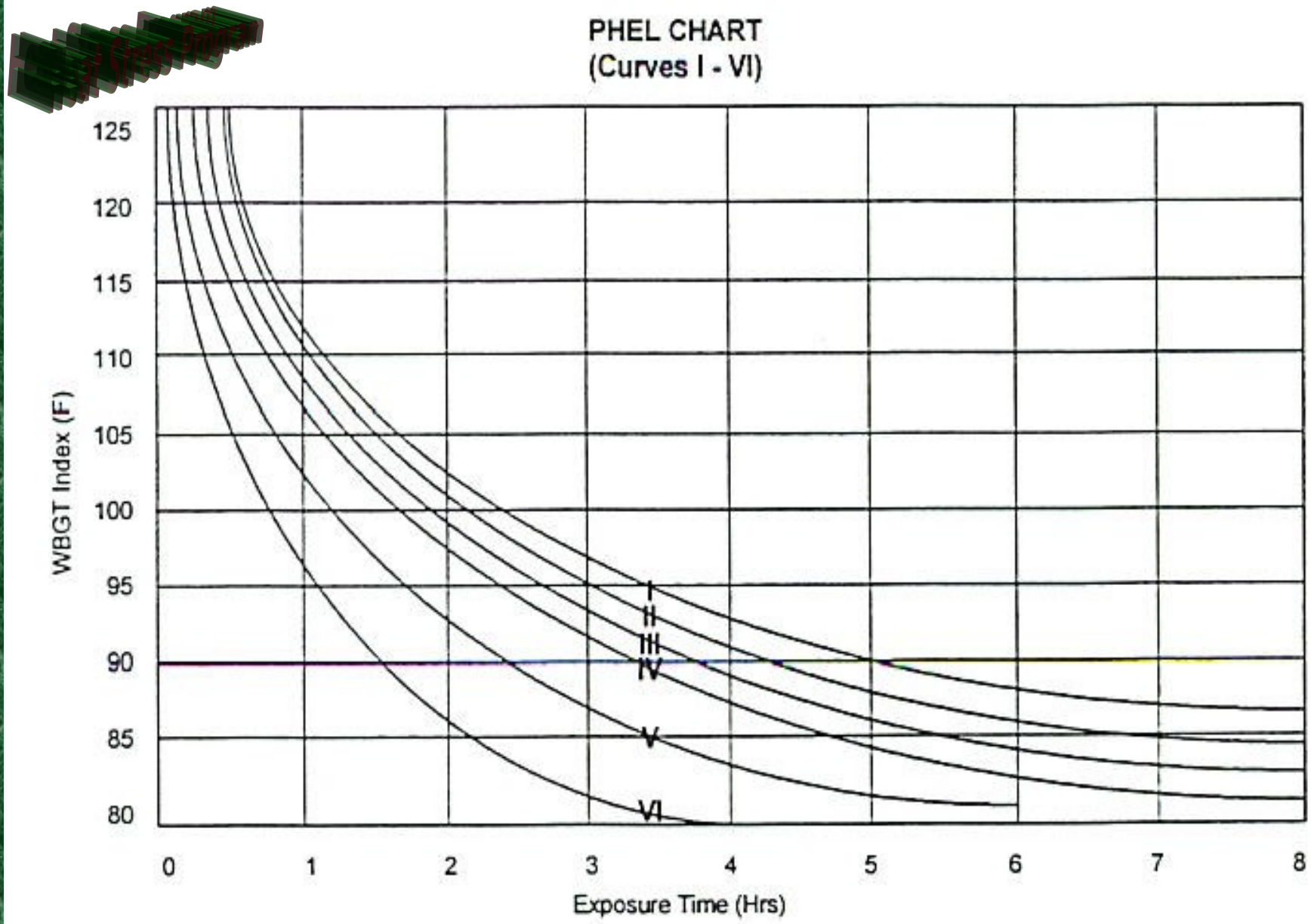
Routing Survey

- EOW
- CHENG/SUPPO
- MEDICAL
- XO
- CO (If stay times are less than watch CO must be notified ASAP)
- Record all heat stress readings and retain for 1 year
  - Engineering/Supply: Dry bulb
  - Medical: All WBGT readings

PHEL Curves

Physiological Heat Exposure Limits

- NAVMEDCOM established for standard heat stress limits
- PHEL Curves I - VI


PHEL CHART
(Curves I - VI)
WBGT Index (F)
125
120
115
110
105
100
95
90
85
80
I
II
III
IV
V
VI
0
1
2
3
4
5
6
7
8
Exposure Time (Hrs)

PHEL Curves

- Watch/Work center supervisors match task to curve
  - Use OPNAVINST 5100.19C CH-2
- For Non-Routine operations use next highest curve
- For personnel with insufficient recovery time use next highest curve

PHEL Curves

- In case of heat injury, all personnel in space go up 1 curve
  - Determine cause of heat injury
  - Correct if possible
  - Return to normal curve

Recovery Period

- Recovery should take place in a cool space for twice the stay time or 4 hours, whichever is less

HEAT STRESS SPACE SURVEYS

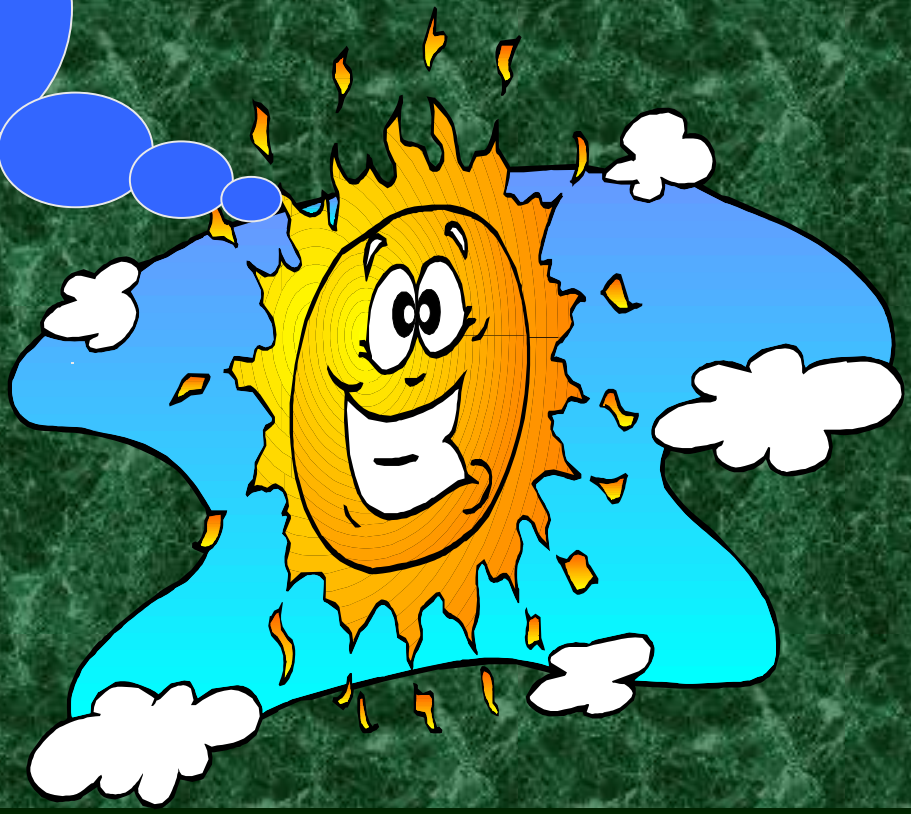
- When temp reaches or exceeds:
  - PHEL I through III:
    - Watch/work 4 hour or less
      - SIB = 100° F
    - Watch/work > 4 hours
      - SIB = 99°
  - PHEL IV through VI
    - SIB = 87° F

HEAT STRESS SPACE SURVEYS

- Engineering Casualty Control (ECC) Drills longer than 3 hours
- Any space where heat injury occurs
- Any space CO wants

HEAT STRESS SURVEYS

No longer need to monitor for outside high heat weather conditions



POTENTIAL HIGH HEAT STESS LOCATIONS

Engineering Responsibilites:

- Engineering Spaces
  - Engine Room
  - Fire Room
  - Aux. Machinery Spaces

Medical & Supply's Responsibility

- Galley-deep sink room, scullery
- Laundry-Washers, dryers, pressers
- Steam catapult spaces

LOOK OUT FOR:

- **DEGRADED MATERIAL**
  - Damaged Lagging
  - Steam Leaks
  - Boiler Air Leaks
- **STANDING BILGE WATER**
- **POOR WORK PRACTICES**
- **LACK OF PMS**
  - Dirty Vents
  - Unauthorized vent alterations
- **POOR SUPERVISION**
  - Program Ineptitude
  - Lack of Knowledge

EMERGENCY OPERATIONS

Emergency Environmental Monitoring

- Damaged or broken meters
  - Globe assemblies
    - Small dents
      - No problem if globe seal not involved
    - Large dents
      - Problem, cause inaccurate results
    - Flat black ultra krylon spray paint can cover scratches

Emergency Environmental Monitoring

- Broken Meter
  - WBGT doesn't work
    - Send back to manufacturer for repair
  - Use Motorized Psychrometer
    - No globe temp
    - Use historical data to estimate GT
    - Document emergency
    - CASREP meter
  - SIMA can calibrate meters

HEAT STRESS PREVENTION

TRAINING

- ALL Hands shall receive heat-stress training upon reporting aboard (I-Div) to include:
  - Heat-stress health hazards
  - Symptoms of excessive heat-stress exposure
  - Heat-stress first aid procedures
  - Heat-stress monitoring
  - Causes of heat-stress conditions

Heat-stress training documented (E250)

Heat Stress Prevention

- Keep an eye on shipmates & watch for symptoms
- Know your own limitations
- Eat well
- Drink water frequently
- Stay away from coffee, soc
  Gatorade, and salt tablets

While adults average 12.8 of 8 oz beverages daily, the Net gain equals 3 glasses of water (8 Recommended)

Because some drinks dehydrate!

Hydrating Drinks:

Water 4.6

Juice 1.4

Milk 1.3

No-Caffeine Soda .6

Hydrating total 7.9

Dehydrating Drinks:

Coffee/tea 2.8

Caffeine soda 1.3

Alcohol .8

Dehydrating Total 4.9

Source: Yankelovich for New York Hospital Nutrition Information Center, International Bottled Water Association

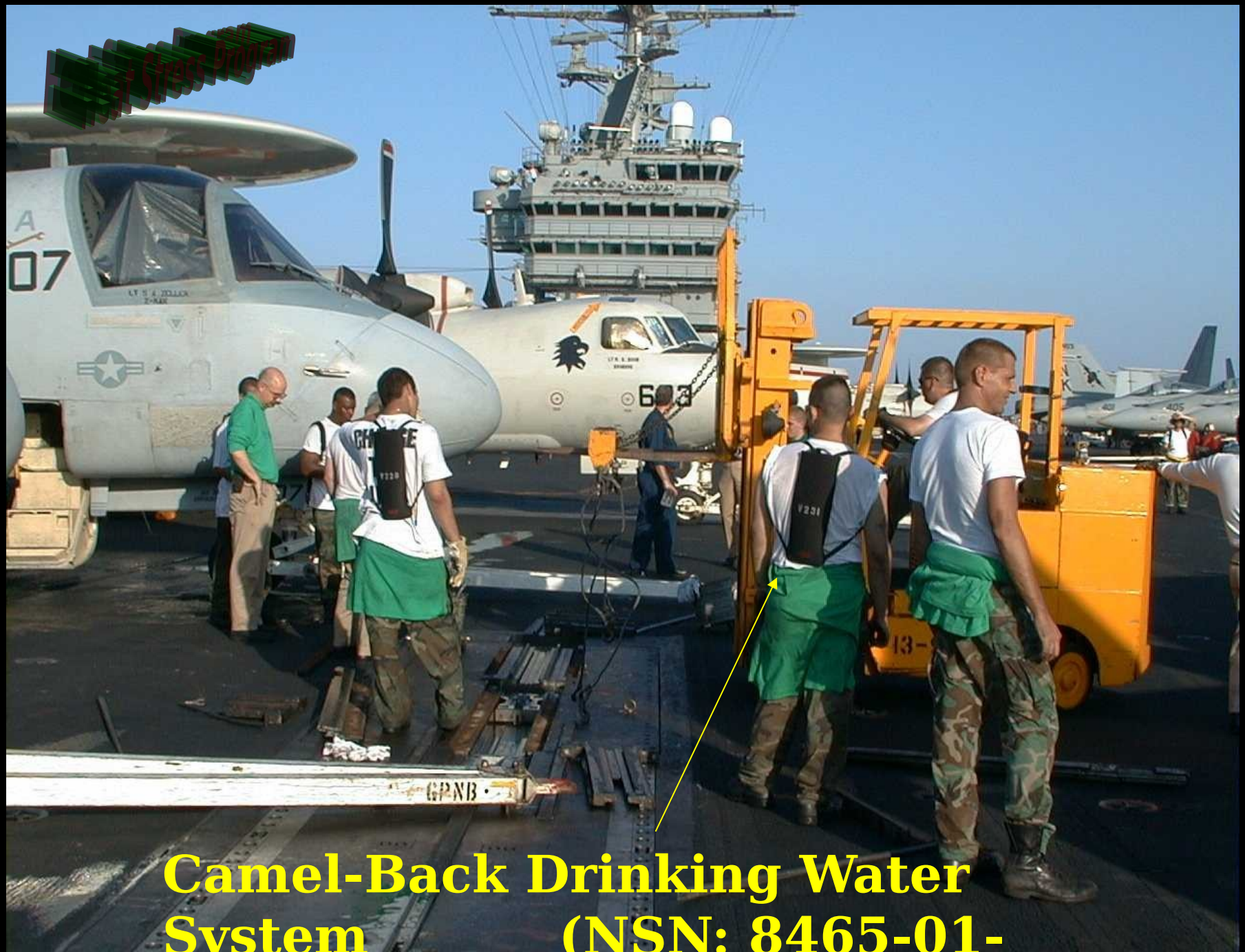
Heat Stress Prevention

- Get plenty of rest
- Allow body to acclimate to heat
- Take required recovery time when leaving heat stress area
- Report heat stress problems (missing lagging, steam leaks, poor ventilation, etc.) asap

Heat Stress Prevention

- **Limit Access Through A/C Boundaries**
- **Isolate Warm Areas (smoke curtains)**
- **Schedule Drills Early/Late in Day**
- **Limit Starch in Uniforms**
- **T-shirts**

INSTALLED WBGT



Camel-Back Drinking Water System (NSN: 8465-01-

Cool-Vest

INVESTIGATIONS/REPORTS

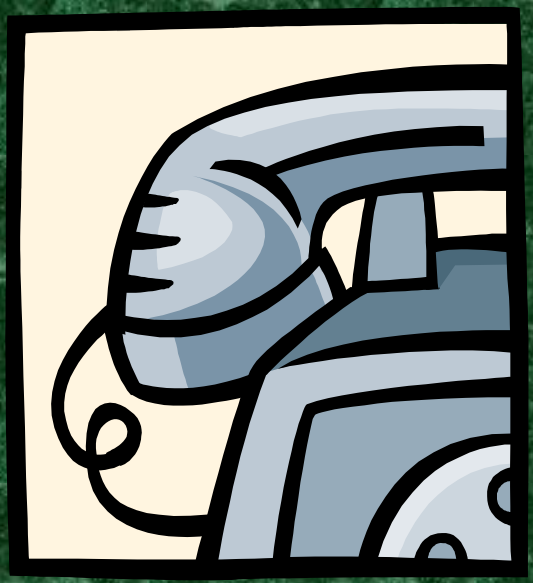
- Heat Injury…… MDR
  - ✓Prepare a Heat/Cold Case form (NAVMED 6500/1)
  - ✓Forward the form to NEHC
- 5 or more lost workdays. . . .Also need to file Mishap Report
- Unconscious…… JAG

COMMON DISCREPANCIES

- ☹Gun Decked Logs (Supply)
- ☹Missing Thermometers
- ☹Poorly Trained Monitors
- ☹Broken Equipment
- ☹Poor/No Program Aptitude
- ☹Incomplete Reports:
  * Meter Validation
  * Outside Temperature Readings
  * Conditions
  * Temperatures

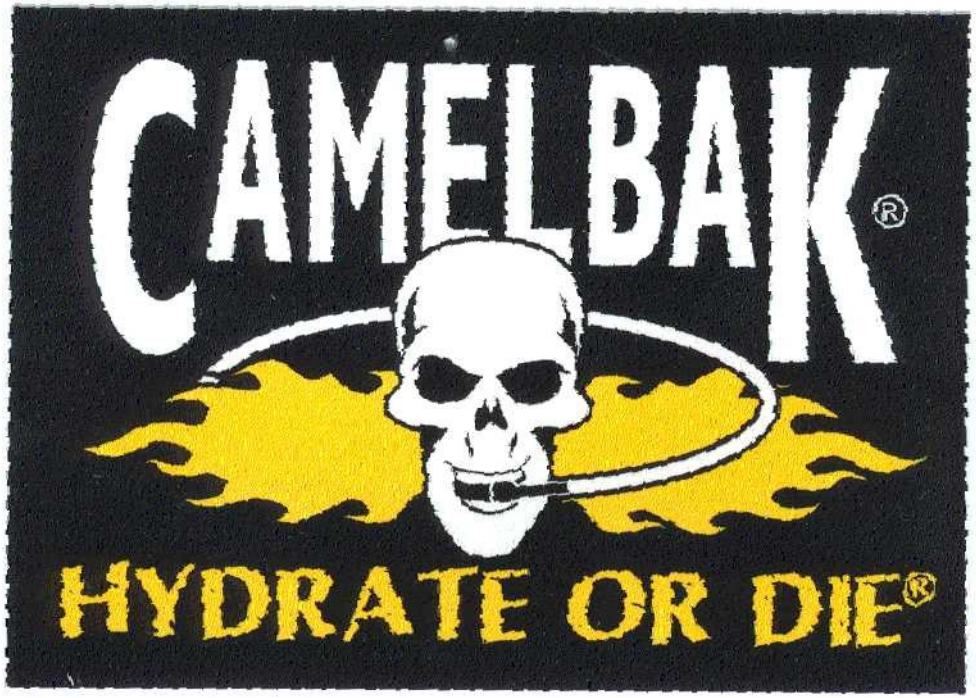
CALL FOR ASSISTANCE

- NEPMU's
- BUMED IH Dept/Div
- Tender
- Navy Safety Center
- CV/CVN IHO



SUMMARY:

- Everyone must take an active role in the Heat Stress Program
- ID of Heat Stress HAZARDS must be part of workplace inspection
- Watch the PAPERWORK
- Prevention is THE key
- Keep the ship as COOL as possible
- Acclimatization
- Hydration. . .Hydration. . .Hydration!!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THE END